

Developing an Information System for a Hospital

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THE HOSPITAL is a complicated corporate entity to administer because its widely divergent objectives and functions engender exceptionally complex demands on management's decision making processes. The institutional objectives entail patient care running the gamut from highly specialized medical and surgical procedures to hotel-like accommodations, using optimally a staff ranging from unskilled workers to highly skilled professionals, and serving as an educational institution as well as a medical research laboratory. Furthermore, the hospital must operate in this manner 24 hours a day, 365 days per year. Thus, any comprehensive electronic data processing system designed for a hospital must handle readily and continually widely ranging, constantly changing requirements.

Visualizing the scope of such a system would entice and intrigue any systems designer, and I can perceive the unique challenge presented by such an undertaking. As medical science advances, requirements for hospital services become greater, and skyrocketing costs impel awareness of the urgent need for a system of operational and management controls to effect more efficient use of a hospital's nurses, bed-

space, equipment, and other costly resources. To these burdens the information-processing demands of Medicare have been added.

The Pilot Project

A comprehensive electronic data processing system has been developed at the State University of New York-Downstate Medical Center, Brooklyn, and portions of the system are operating. The pilot system that was implemented has three major subsystems: one for operations control, a second for reporting to management, and a third for responding to inquiries. Each subsystem interrelates and uses the same data, but for different purposes. The operating control subsystem uses data in relation to control of day-to-day operations of the hospital. The management reporting subsystem uses the same data in summary reports to facilitate informed decision making. The information inquiry subsystem makes the data available for either operational or management purposes and for research. Thus, the design had to be comprehensive in scope while the development has been modular in implementation.

To simplify the input requirements of such a system, they were approached with an integrated concept so that data needed to be placed in the system only once to make them generally available after recording them initially in machine-readable form. Because of the hospital's large volume of data, wide variety of information, and full range of research interests, building

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toward a real-time, on-line system was the only practicable means to satisfy its numerous requirements.

The acronym, THOMIS, standing for Total Hospital Operating and Medical Information System, was chosen for this complex of computers. After investigating competitive hardware, an IBM 1410 computer system was chosen to meet the hospital's basic requirements. These requirements included telecommunication ability, monitor operating systems for expandability and flexibility, and systems manpower support.

As THOMIS initially developed, the telecommunication requirements grew drastically, prompting the order of an IBM 1440 computer to be used in conjunction with the 1410 as an on-line, channel-connected telecommunications buffer and message-editing unit. These two computers enabled up to 40 remote typewriters to access the system simultaneously, thus improving the system's through-put capability.

In order to receive and transmit data as rapidly and as accurately as possible, more than 50 IBM 1050 remote terminal stations were installed for use with this configuration. These terminals included typewriter, punchcard, paper tape, and matrix keyboard input-output capabilities. In addition, the IBM 1001 data-phone was chosen for transmission of information about patients to the computing center for processing.

The 1440 computer functions primarily as a message-handling and transmission unit, receiving the processed messages from the 1410 and transmitting them to the proper 1050 terminal. This enables handling up to 40 messages simultaneously.

The power and flexibility of this equipment enable incorporation of a variety of operations into THOMIS. These operations include admitting and discharging patients, ordering goods and services for the hospital and its patients, billing and posting accounts receivable, scheduling outpatient department appointments, effectuating a basic electronic medical record for each patient, and summarizing the hospital's patient care activities.

Methods of cost accounting, statistical analysis, and management reporting are being investigated and developed.

In addition the medical records study has stimulated interest in summaries of nursing activity, summaries of data about patients, on-line requests for specific data about patients, and other uses of clinical data.

To further the art of electronic data processing in hospitals, widespread use of remote, on-line communications terminals is being made at the Downstate Medical Center. The following objectives were established for the THOMIS pilot project.

1. Control of the hospital's workflow.
2. Improved service to patients by reducing nurses' clerical tasks.
3. Aid to medical education.
4. Integration of medically oriented and administrative functions.
5. Greater efficiency and accuracy of handling data with greater ease of input.
6. Faster reporting cycle.
7. Facilitating administrative research for better hospital management.

Applications

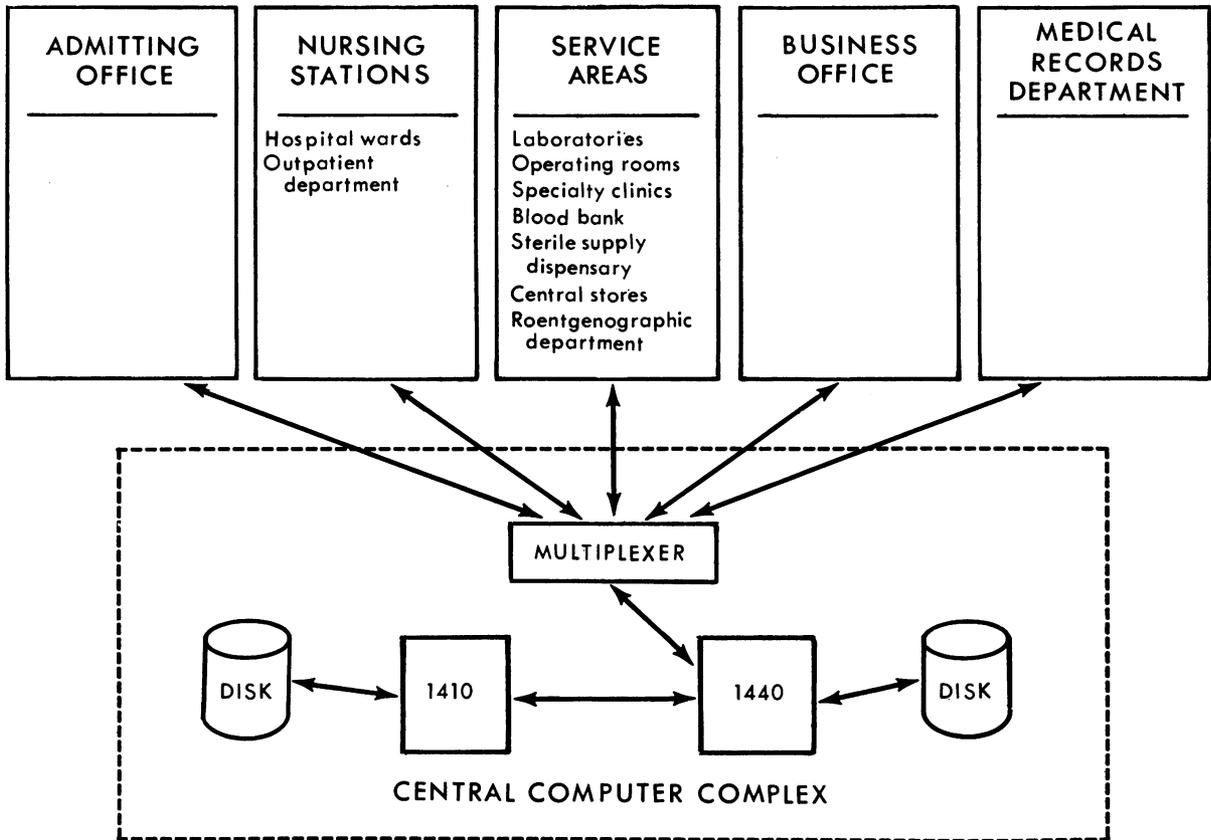
The system was developed initially around basic, functional activities in the hospital. These activities included admitting and discharging patients, ordering goods and services for both patients and personnel, billing and collecting accounts receivable, scheduling outpatient appointments, and developing electronic medical records (see chart).

In addition, the computer subsystems support accounting and cost analyses and generate all statistical reports. The activity summary enables development of most operational reports as it organizes and summarizes the data.

Used for both inpatients and outpatients, the admitting and discharging system handles information about the patient's admission, bed transfers, and discharge. Data about the patient are gathered and entered into the system before he is admitted. The information stored on both tape and disk includes personal, financial, and guarantor data as well as expected date of admission. On the eve before admission all data are placed in the disk file for use the next day. (Since accident victims and emergency patients usually are not sent to the State University Hospital, these procedures are feasible and practical.)

General system schematic of THOMIS

Remote terminal locations in State University Hospital, Brooklyn, N.Y.



When the patient arrives, the 1050 remote control terminal station in the admitting office is used to request and assign a bed and notify the nursing station and telephone office of the patient's admission. The patient and his records, including his identifier card, are taken to his room. This card contains the patient's unique hospital number which will be used to identify all orders, specimens, records, and other material pertaining to him.

The ordering system provides for ordering and charging services and inventory control of goods. Each nursing station has a set of keyboard overlays, one or more of which identifies each service area. Service areas included in this system are laboratories, operating rooms, specialty clinics, roentgenographic department, blood bank, pharmacy, sterile supply dispensary, and central stores.

To place an order into the system, the floor manager at the nursing station enters the order

into the computer by using an IBM 1092 matrix keyboard. (The keyboard, part of the on-line 1050 terminal system, replaced the 1001 dataphone.) The overlay identifying the service area to receive the order is placed on the keyboard, and the patient's identification number, the particulars of the order, and the physician's identifying code number are manually inserted into the keyboard.

Upon receipt of the order by the computer, which occurs in fractions of a second, the computer generates a typeback, that includes the patient's name, to the nursing station's 1050 remote typewriter to validate the order. Orders which must be processed immediately are transmitted to the 1050 terminal of the service area affected. These procedures simultaneously update the disk files and create an audit trail record on magnetic tape.

The billing and accounts receivable system provides the patients' statements on demand and

cyclically, proration of charges between patients and insurance companies, and billing to the insurance companies. This system also maintains accounts receivable from patients. Besides the weekly statement on which the charges are listed and prorated, patients also receive a demand bill when discharged.

When a patient is to be discharged, the floor manager will use the on-line keyboard to transmit an order for the demand bill. The bill, showing the balance forwarded from previous billing and the charges incurred since the last billing date, is printed on the 1050 in the business office, ready for collection or financial arrangement.

The outpatient scheduling system provides for maintaining appointment records of patients who will see fourth-year medical students selected to staff the outpatient department. Data pertaining to the patient's admission are entered through the 1050 station at the outpatient control desk.

On the basis of the tentative diagnosis of the patient's illness, an appointment is scheduled with a selected medical student. This student, supervised by a preceptor, attends the patient.

Revisits are scheduled and orders for the patient are transmitted to the computer via on-line matrix keyboard terminal. Besides producing schedules for the student-physicians and the outpatient department's clerical personnel, the system generates appointment reminder notices to be mailed to the patients.

The activity summary system provides an integrated approach to file maintenance and generation of reports. This system daily processes each file by that day's hospital activity. Report files are extracted from the basic data files, and the various schedules, inventories, and statistical reports are run. This system also provides entries into the accounting and cost systems, thereby enabling administrative and accounting control reports required for knowledgeable management and decision making in the hospital.

The medical records system will develop electronically stored medical records which can be used for patient care, education, and research purposes. The success of the system will depend on widespread use of patients' social security numbers as their medical records file numbers.

Consistent use of a single number for each patient will create unified records both for inpatient and outpatient data storage and retrieval.

Information to be stored on these tapes will include each patient's socioeconomic data; personal, family, medical, and surgical histories; observations recorded during physical examinations and results of laboratory tests; diagnoses; and the discharge summary narrative. From this file it is planned to retrieve selected patient records based on criteria presented by the physician, educator, or researcher. Various indexes (for example, of diseases, operations, and physicians' professional experiences) and medical statistics also will be generated by this system.

Conclusions

The "Total Hospital Operating and Medical Information System" (THOMIS) is not static. The system is built to accommodate the growth that is anticipated in development of hardware and in application.

Beginning with the use of the off-line IBM dataphone 1001 and the on-line IBM 1092-1050 for data transmission in conjunction with IBM 1410 and 1440 computers for data processing, I foresee hardware growth up to the use of the dual IBM 360 computers or similar hardware for information processing and message transmission and use of visual display terminals for output review.

Starting from the bases of admitting, ordering, billing, outpatient department scheduling, summarizing activities, and developing medical records, I foresee expansion into dietary planning, preventive maintenance, and additional services as well as expansion of real-time access to medical records data, extension of the accounting system, and interaction with affiliated hospitals.

The challenge and the need are to develop systems which can provide management with information necessary to control hospitals. The challenge and need also include supportive manpower for medical activities of institutions. THOMIS, the response to these dual needs, successfully marks the beginning of the enlightened use of data processing equipment in the implementation of an operational hospital information system.